

Thomas Edison and the Theory and Practice of Innovation

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In December 1990 *Financial World* took a poll of the Business History Conference to determine the most important individuals and organizations in the business world in the past hundred years. The poll set out to find the greatest business leaders of the twentieth century, the most important companies, and the biggest business flops. Apart from the question about the most important invention of the twentieth century, it is doubtful if Thomas Edison's name will be mentioned in the responses to the poll, for here is a man associated more with invention than with management and a historical figure that belongs more in the nineteenth century than in the twentieth. Yet as an innovator who set out to manufacture and market his inventions, Edison set in motion a strategy that continues to dominate American business. In a career that bridged the nineteenth and twentieth centuries, Edison was an important pioneer in the innovative business organizations and strategies that are now claimed by some of America's most successful companies. Edison deserves to be recognized as an important business leader of the twentieth century.

The Reluctant Industrialist

In addition to a nomination for creating one of the important companies of the twentieth century, Edison also deserves a nomination as the architect of some of America's greatest business failures. His reputation as a businessman has never been very great. His friend Henry Ford summed it up when he said that Edison was the world's greatest inventor and worst businessman [6]. The history of the electric utility industry serves to prove this point and to support the notion that inventors and engineers do not make good managers. After inventing the incandescent lamp and building the central station system to bring electric light to city dwellers, Thomas Edison formed many companies that made the equipment and provided the service. When

¹I wish to thank the National Park Service for access to the Edison National Site, West Orange, New Jersey, where the Edison archives are held. All Edison quotations come from documents in this archive and can be referenced by consulting my book, *Edison and the Business of Innovation* (Baltimore, 1990).

these companies were amalgamated into General Electric in 1892 the great inventor was given only a nominal role as a member of the board. The newspapers at that time and later historians have agreed that Edison was "frozen out" of the industry that he had created, a victim of the manipulations of big business and his own poor judgement [3].

Edison's follow up to the great success of electric lighting was an unmitigated disaster. His plan to magnetically extract iron from low grade ore went against the conventional wisdom of the mining industry. Edison built a huge mill in the mountains of New Jersey and poured away the profits of electric lighting trying to make it work. The total failure of this project brought him close to bankruptcy. It is no wonder that management experts, such as Peter Drucker, tend to depict Edison as a disastrously bad manager who ruined the companies formed to develop his inventions [4]. Edison himself attempted to downplay his role as a businessman by stressing the fact that he was an inventor who preferred to stay in his laboratory. A reluctant industrialist, he claimed that he was forced into financing inventions and building factories because entrepreneurs were too timid to do the job themselves.

This story, like many others concocted by Edison, was completely untrue. It was part of his successful creation of an Edison myth and a ploy to keep him out of the litigation that invariably accompanied his business activities. Edison's theory of innovation was based on the inventor playing the central role in manufacture and marketing. He claimed that any money he made was from manufacturing the invention and not selling the patent. He described himself as an inventor or as a manufacturer; he saw the two functions as overlapping. He did not use the term innovation to cover the activities of setting up a commercial enterprise upon an idea, yet this was clearly in his mind when he claimed that coming up with ideas for inventions was easy but it was "the long laborious trouble of working them out and producing apparatus which is commercial" that required the hard work.

Edison was certainly not content to be just an inventor, a person who turns ideas into patents. He believed that a patent was hardly worth the trouble of inventing something. He knew from experience that selling patents to businessmen often left the inventor shortchanged. More often than not the returns from a new idea went to the financier or manufacturer, while the inventor struggled to protect his patent in the courts and obtain his share of the profits. A patent alone was not enough, nor was an invention. The original idea had to be developed into something more tangible than a patent; it had to be transformed, or "perfected" into a working model or a final product--something a businessman could see and touch rather than imagine. This was essential to obtain financial support. In Edison's words, the "money people" had to see money in an invention before they would invest in it. "Perfecting" an invention also involved finding and remedying the "bugs"--the defects and design problems--that inevitably cropped up in the development of an idea into a working model or process. This stage of innovation ended when the invention was translated into a factory-ready prototype. Its value was now much greater than a patent. The final step involved "pioneering" a technology by putting it into production and proving its commercial feasibility. This

involved financing a manufacturing operation and administering it until it could be sold to entrepreneurs.

Innovation covers what Edison would have called inventing, perfecting, and pioneering a new technology. He had plenty of experience of innovation by the time he set up his "invention factory" in Menlo Park, New Jersey in 1876. This prototype of the modern research and development organization was designed to produce a stream of new products, and the invention of the phonograph, high resistance incandescent lamp, and many improvements in telegraphy proved that innovation could be regularized and placed in the format of mass production. It was at Menlo Park that Edison demonstrated that he was not content to merely develop new products, for he was determined to control all stages of innovation, especially the manufacturing stage where he could employ the resources of his laboratory to continually reduce the cost of production. He began to manufacture incandescent bulbs at Menlo Park and to think seriously about setting up factories to mass produce his invention [5]. The large factory that he set up in Harrison, New Jersey marked an important point in his business career, for it was at Harrison that he discovered the major article of faith of American manufacturing in the nineteenth century: the cost of making a product could be successively lowered as the manufacturer moved along the learning curve of mass production technology, and at each cost reduction more customers were attracted to purchase the product. The invention factory was to be used to progressively lower the cost of production. The miracles of cost reduction that had been achieved at the Lamp Works could surely be applied to other products.

Edison consequently formulated a grand strategy for a new laboratory, envisaging a large industrial undertaking that would manufacture the many new products devised in the laboratory. In 1886 he began its construction at West Orange, New Jersey. His close associate Charles Batchelor was told of this scheme while the laboratory was being built. He wrote in his diary: "Edison's idea now for the future is to get up processes for manufacture and start factories...as soon as the new laboratory is finished this will be commenced in earnest " [7].

The Manufacturing Strategy

Edison's plan was not to create another large scale enterprise like electric lighting, but a focused manufacturing operation to bring consumer durables to a mass market. With the enormous costs of introducing electricity still fresh in his mind, Edison wanted to avoid "cumbersome inventions like the electric light" and concentrate instead on small products with a high profit potential and low capital requirement; he planned to supply small items of commerce--"useful things that every man, woman and child wants."

As an industrialist in the 1870s and 1880s, Edison knew that he could use the telegraph and railroad to reach a national market. Perhaps influenced by the success of the sewing machine, he saw an important new market for consumer goods opening up at that time. American cities were growing at a furious pace. Between 1880 and 1900 the urban population of the United

States moved from 28% to 40% of the total. With the great boom in railroad construction over, cities were becoming the most important market for manufactured goods [2]. After considering a wide range of potential products, Edison decided to concentrate on making office machinery, including the electric fan and the phonograph. The latter could be turned into a dictating machine and Edison believed that its recorded cylinder--the phonogram--was going to replace the letter and the memo in American business.

The construction of the Edison Phonograph Works in 1888 completed the plan for his West Orange operation--a large manufacturing facility adjoining a laboratory complex, and all under the control of one man. In controlling manufacture, and ultimately the supply of raw materials, Edison was covering ground that normally is reserved for the large, integrated corporation. Yet at the same time, he had constructed a research laboratory that was equipped to move quickly into new technology, taking the larger organization with it.

His desire to remain in complete control of his inventions reflected the unhappy experiences of selling interests in his projects to financiers. The bankers, entrepreneurs, and professional managers he dealt with were much too conservative and cautious when it came to introducing a new technology. There were few businessmen in America in the 1890s who could match Edison in gambling a fortune on a new idea. The ore milling project was a case in point. The millions of dollars he made in electric lighting were quickly poured into this ill-fated venture as he liquidated his interest in electric lighting to finance his ore mill. He persevered in this losing proposition because he knew that if he succeeded the profits would be around \$3 million a year--far exceeding the return on electric lighting--and they would go to him alone.

Ore milling was the "most commercial" technology Edison had ever devised. One hundred year later we see only the colossal failure and not the potential for profit. Historians have estimated the value of those General Electric shares if Edison had hung on to them--forgetting that while Edison was losing a fortune in his ore-milling project the electrical utility industry was going to the wall. The great depression of the nineteenth century that began in 1893 provided the financial shock that nearly brought down the electrical industry. Edison believed that the great companies such as General Electric and Westinghouse had too great a burden of debt and that there were few profits to be had in providing electric light. The decade of the 1890s proved him right [9]. The same decade also proved that money could be made in manufacturing consumer durables for the growing urban market. By 1900 Edison had rebuilt his business empire around the phonograph as an entertainment machine that would go into every home. He also made the prerecorded cylinders that were played on the phonograph. By 1906 he had manufactured over one million machines and twenty million recordings--the phonograph industry was enjoying a boom period that would last until the early 1920s.

At the turn of the century Edison was also enjoying the profits of another new industry that had been created around one of his inventions. The motion picture camera was one of many new products that came out of the West Orange laboratory; it occupied a place in a list of inventions that began

with the aeroplane and ended with X-rays. Many of these stunts, as the laboratory staff called them, came to nothing. Several were taken up by other inventors and brought to a successful conclusion elsewhere, such as radio. But it took only one successful stunt to make good the losses on all the failures. The invention of motion pictures reestablished Edison as the world's greatest inventor after the loss of face in the electrical industry and the disaster of ore milling. It was no less a triumph for his business enterprise; the first viewing machine, called the Kinetoscope, was a vanguard of a new industry [8].

The success of the motion picture stunt proved the worth of Edison's basic business strategy of creating a diverse product line on the stream of new products coming from his laboratory. An assembly line was set up for each new product and, if early sales were encouraging, Edison quickly set up companies and built factories. The speed with which he moved into new areas might horrify modern businessmen who prefer years of preparation and market research before embarking on a new venture. But Edison was always something of a gambler and the years of intense competition in the telegraph and electrical industries had taught him the merits of moving quickly once a commercial technology had been developed.

This strategy was not without pitfalls, for the hasty introduction of a half-realized product could end in disaster, and there were several of these in Edison's long business career. Yet he was never one to dwell on failure, and there was always another promising stunt in the laboratory to make up for past reverses. The motion picture project was pushed forward when it was obvious that the ore-milling project was doomed. The diversity of experimental projects undertaken at the laboratory gave the Edison enterprise the means to ride out competition and depressions in one business. It was also the path for continued growth and expansion. The facilities erected at West Orange were the basis for the continual, systematic entrepreneurship that we now see as essential to remain competitive in the modern business world.

Thomas A. Edison, Incorporated

The Edison enterprise enjoyed a marvelous period of growth after the worst of the depression was over by 1896. By 1910 the Edison product line included phonographs, film projectors, electric fans, storage batteries, Portland cement, and motion pictures. He owned recording studios, film making units, mines, and quarries in addition to the great industrial complex he had built at West Orange. There had been little planning in the assembly of Edison's business enterprise. He pursued the policy of expansion without regard to the overall development of the organization, forming new companies and building factories as the need arose. Each new product led to a new company and often to a new manufacturing facility.

Edison also embraced the strategy of vertical integration, acquiring the facilities to control each stage of production in much the same way that Andrew Carnegie integrated his steel making operations and John D. Rockefeller brought all stages of oil production and refining under one organization. In addition to the current economic wisdom of securing the sources of raw materials and lowering costs, there were good technical reasons

to take over the production of raw materials. The requirements for chemicals needed in the manufacture of batteries and phonograph records were unique to Edison's operations; the purity of raw materials played a major part in determining the quality of the final product. Even the slightest impurity in the chemicals used to make wax compounds, for example, could ruin the reproduction of sound from the phonograph. Edison's standards were the highest in the industry, and therefore only his own raw materials were to be used in manufacture.

An example of this policy was the Edison storage battery. He had embarked on an experimental project to improve storage batteries because he was convinced that a better battery would have a much larger market than the lead-acid battery then in use. One new use of an improved battery would be the electric car--a product that appeared to have a bright future at the turn of the century. He envisaged controlling the storage battery operation from the mine providing the basic raw materials to the assembly of electric automobiles and started in this direction as soon as the project began. He acquired mines, constructed factories, and purchased the Lansden Electric Car Company of Newark in 1908.

Where possible, Edison attempted to gain control of companies providing parts or materials for his factories. He bought out smaller competitors in the New Jersey area and also acquired an interest in factories in Europe making his talking machines and records. The size of his business places it in the front rank of the larger organizations formed in the era of consolidation in American industry. In 1910 Edison began to reorganize his sprawling business empire into an organization that was easier to manage. He formed Thomas A. Edison Incorporated (TAE Inc.) as the umbrella organization under which he could consolidate his many business concerns.

The policy of diversification had created many businesses in the Edison enterprise, each one with its unique technology. Each of his products had a different market: primary batteries were sold largely to the railroad industry, storage batteries went to industrial users and delivery companies, the dictating machine was marketed to the business community, and the phonograph and motion picture were articles of mass consumption which demanded a special knowledge of the world of entertainment. The rapid swings of public taste in phonographs and motion pictures had shown how important it was to react quickly to changes in the market. The divisional policy was framed with this goal in mind. It was intended to move decision-making closer to the customer by giving middle managers the opportunity to exercise their special technical or marketing skills. It created channels for their input within the organization, providing the timely information with which to better apply the engineering and manufacturing resources of TAE Inc. to a changing market situation.

The evolution of the modern business organization has been chronicled by the historian Alfred Chandler. He has shown that the multidivisional, decentralized structure came as a response to problems of running the large diversified businesses created during the merger movement at the turn of the century. Companies diversified into new product lines to use their resources more profitably, but as they took on more types of products, they required a new organizational plan for the administration of their complex businesses.

The divisional structure answered many of their needs and it eventually became the standard of business organization in the twentieth century. Beginning with Du Pont and General Motors, Chandler has described how big business in America embraced this structure [1].

As Edison's policy of diversification came two decades before those of Du Pont or General Motors, his move to a divisional structure precedes theirs by several years. The divisional policy was laid out by Edison and announced on March 15, 1915. It allotted each major product in TAE Inc. to a separate division, each the responsibility of a division manager. The divisional structure was modelled on the United States government; the central administration was the federal government, each division was a state, and the division manager was the state governor. The central administration was to give the division managers "as wide latitude as possible," after setting general policy. Its function was to coordinate the activities of the divisions.

At the top of the divisional structure stood Edison. He did not concern himself with the day-to-day affairs of the divisions but with the overall strategic planning of the enterprise. As chief executive and founder of the operation he wielded total power. Although TAE Inc.'s divisional structure was years ahead of its time, Edison remained firmly committed to the personal leadership in the mold of the nineteenth century family business and was reluctant to hand over control of his business to professional managers. His frequent retirements were followed by a sudden return to West Orange and a sharp change of course from twentieth century enlightened management to nineteenth century capitalism. He hired professional managers and then overruled their decisions, making several critical errors of judgement that were to cost TAE Inc. dearly in the phonograph business. Edison refused to move into radio and electronic recording in the 1920s and therefore lost the technological leadership that had used to be the hallmark of his business enterprise. His own personal taste determined what records and films his company made, and the results were completely out of step with the changing audience expectations of the 1920s. Edison hated jazz and his company missed the great boom in new popular music in the 1920s. His choice of film subjects tended towards themes that would not provoke censors. Advertised as "clean and wholesome" fare that would entertain and educate, Edison pictures did not provide the titillation and violence that sold seats in movie houses.

TAE Inc. was forced out of two industries created by the inventions of its founder, leaving the film making business in 1918 and finally ending the production of phonographs and records in 1929. In terms of the consumer market, the Edison enterprise could not keep up with the times. The closing down of the phonograph operation--a humiliating step for the inventor of the talking machine--while being honored as the great innovator is an indication of the gulf that had arisen between the Edison image and reality. Despite several disastrous business reversals in the 1920s, the Edison myth continued to grow more potent in America. In 1929 his great invention was honored in "Light's Golden Jubilee." While he was being lionized during these celebrations of an America gone by, his customers were deserting the products based on his traditional values and aesthetics. The competition had

successfully labeled his products old fashioned, and TAE Inc. struggled in the consumer markets.

Conclusions

The Great Depression was two years old when Edison died. The organization did survive the Great Depression, just as it had survived the depression of the nineteenth century and the depressions of 1907-8 and 1920-21. Edison senior had turned over a resilient business to the next generation. In 1887 he had looked into the future and envisioned a great industrial complex, telling a financial backer that "I honestly believe that I can build up a works in 15 to 20 years that will employ 10 to 15,000 men and yield 500 per cent to stockholders." Although he did not produce a business enterprise to rival that of Standard Oil or U.S. Steel, he did go a long way in achieving this goal. At the time of his death, TAE Inc. was returning a dividend and had an average yearly surplus of \$7 million.

The divisional structure of TAE Inc. had helped it weather the storm of the Depression and the decline of its core phonograph business. Edison's policy of diversity, established in the 1890s, proved to be the salvation of the company for as one product went into decline, there was another to take its place. The storage battery and dictating machine kept TAE Inc. solvent in the 1930s and made up for the loss of the phonograph business. The instrument division matured in the 1940s and helped arm America during the Second World War, providing a basis for the electronic and precision products made in the 1950s.

Edison's contributions to the quality of life in the industrial West have often been acknowledged. The U.S. Congress passed a resolution expressing the nation's thanks to the great inventor "whose conquests in the realm of science have enriched all human life." After his death a host of tributes underlined his pioneering role in many of the wonders of modern industrial society, making Edison the "father" of everything from electronics to charcoal barbecuing. His contributions to American business have received much less attention. To Edison must go the honor of inventing the idea of industrial research--a permanent research establishment devoted to improving old products and finding new ones. He also originated a method of managing this activity and organizing a business enterprise around the flow of new ideas and products coming from the lab. Edison was the pioneer of a diversified business based on industrial research.

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